PAVEMENTS MAINTENANCE AND REPAIR IDIQ

DELIVERY ORDER

TO

REPAIR IRISH HILL ROAD, NEWPORT

PREPARED BY AFRL/RIOC

AIR FORCE RESEARCH LABORATORY
ROME RESEARCH SITE
ROME, NEW YORK

PROJECT NR: ULDF 98-0022

DATED: 31 MARCH 2009

PROJECT REQUIREMENTS

1.01 SCOPE

A. Correct the vertical alignment of the roadway crossing the ravine by raising the elevation of the sag vertical curve and reducing approach grades.

1.02 ITEMS OF WORK

1. Reconstruct road as indicated on the attached drawings.
2. Remove and replace existing 48 inch corrugated metal pipe with a new 48 inch Class IV Reinforced Concrete Pipe.
3. Provide and install gutter along both sides of the roadway in the lower portion of the sag vertical curve as indicated on the attached drawings.
4. Reconstruct stone lined drainage ditches affected by the roadway realignment as required to maintain present drainage pattern as indicated on the attached drawings.
5. Relocate fiber optic and telephone lines as indicated on the attached drawings.
6. Special requirements are attached:
    a. Section 9, Test procedures
    b. Section 08520.514, Sawcutting
    c. Section C680.5170, Manhole
    d. Section C680.9672, Fiber Optic Cable
    e. Section C680.93534811, Telephone Cable

1.03 FIELD MEASUREMENTS

A. The Contractor shall verify all measurements and be responsible for dimensions, fitting and proper trimming of items directly connected with all work described in this Contract. The Contractor shall immediately notify the Contracting Officer of any discrepancy prior to starting the work.

1.04 MATERIAL SUBMITTALS

A. The contractor shall submit the items using the attached AF Forms 3000.

1.05 MAINTENANCE OF TRAFFIC

A. During the replacement of the 48-inch culvert carrying the stream under the roadway and the placement and compaction of the additional roadway embankment, the Irish Hill Access Road will be closed to traffic. The Irish Hill Radar Site will be accessed during this time from the alternate entrance off Hawthorne Gulf Road. Because the Irish Hill Radar Site and access road are not open to the general public, off-site detour signage will not be posted. Detour signage will be posted at the entrance gate on the Irish Hill Access Road directing vehicles to the Hawthorne Gulf Road entrance. The period(s) of roadway closure will be coordinated with the Air Force Research Laboratory, Rome Research Site.

C680.9672 M - CABLE, FIBER OPTIC, SINGLE MODE, ARMORED, INSTALL (72 FIBERS)

DESCRIPTION

The Contractor shall furnish and install single mode fiber optic cable of the size and types at the locations shown on the Plans and perform all required testing in accordance with the Contract documents or as ordered by the Engineer and/or an IFOS Communication representative.

MATERIALS

Equipment to be installed as part of this bid item includes the following:

1. Single Mode Fiber Optic Cable
2. Fiber Optic Cable Connectors and Splices
3. Fiber Optic Splice Trays
4. Fiber Optic Splice Cases

Other passive components that are required to form a complete communication system include (1) terminators and (2) moisture and water sealants and cable caps for below grade applications. The components supplied shall be commercially available components whose specifications indicate state-of-the-art capability for the application.

The single mode fiber optic cables to be provided shall be loose buffer tube and of all dielectric design and dual-window (1300nm and 1550nm) fiber cable design as specified herein.

Cables for outside environment shall be armored, non-armored, pre-assembled in innerduct, and shall incorporate filling and flooding compounds.

The construction and testing of the fiber optic cables shall meet or exceed all applicable REA/RUS Specification (PE-90), Electronic Industry Association/ Telecommunications Industry Association (EIA/TIA), American Society For Testing and Materials (ASTM), Bellcore, National Electric Safety Code (NESC) and Underwriters Laboratory (UL).

OUTSIDE CABLE

Operating Temperature

Storage:	-40°C to +70°C
Long Term:	-40°C to +70°C

Optical Fibers

The single mode optical fibers to be contained in the manufactured cables must have characteristics that will allow signals, having a range of wavelengths, to be carried simultaneously.

C680.9672 M - CABLE, FIBER OPTIC, SINGLE MODE, ARMORED, INSTALL (72 FIBERS)

The single mode fibers within the finished cable shall meet the following requirements:

Core Diameter	8.3 micrometer, Nominal
Cladding Diameter	125 ± 2.0 micrometers
Coating Diameter	250 ± 15 micrometers
Core to Cladding Offset	1.0 micron or less
Mode Field Diameter	9.3 ± 0.5 micron at 1310 nm
Cladding Non-Circularity	< 2%
Attenuation:	< 0.35 dB/km @ 1310 nm
	< 0.25 dB/km @ 1550 nm
Attenuation at Water Peak	2.1 dB/km @ 1383 ± 3 nm
Zero Dispersion Wavelength	1300 to 1322 nm
Zero Dispersion Slope	0.092 ps/(nm²-km)
Maximum Dispersion:	3.3 ps/(nm-km) for 1285 –1330 nm
	< 18 ps/(nm-km) for 1550 nm
Cut-Off Wavelength	< 1260 nm
Reflective Event	no greater than –60dB
Proof Tensile Test	0.35 gigapascal
Maximum Macrobending Loss:	<0.1 dB @ 1310nm
	<0.5 dB @ 1550 nm

All optical fibers in any single length of cable must be of the same type.

Buffer tubes

The optical fibers shall be installed in a loose tube buffer and must have a clearance between the fibers and the inside of then container sufficient to allow for thermal expansions without constraining the fibers. The protective container must be manufactured from a material having a low coefficient of friction sufficiently low to allow optical fibers free movement.

All protective coverings in any single length of cable must be continuous and of the same material except at splice locations.

Buffer tubes shall be made of a tough abrasion resistant material to provide mechanical and environmental protection of the optical fibers, but permit intentional scoring and breakout, without damage to the internal optical fibers.

Optical Fiber, Buffer Tube and Core Binder Color Coding

The color designated for identification of loose buffer tubes individual optical fibers and core binders in multifiber tubes shall be colored coded in accordance with EIA/TIA - 598. Any other color-coding scheme must be approved by the Engineer and/or an IFOS Communication representative.

C680.9672 M - CABLE, FIBER OPTIC, SINGLE MODE, ARMORED, INSTALL (72 FIBERS)

Strength Members
Strength members must be an integral part of the cable and manufactured from all dielectric materials. The combined strength of all strength members must be sufficient to support the stress of installation and to protect the cable in service.

The fiber optic cable shall consist of two strength members, central core and a tensile strength member annular serving stranded evenly around the cable core.

Cable Core
The buffer tubes shall be stranded around the central core member using stranding methods, lay length and positioning to form a cylindrical cable.

All core binders shall be non-hydroscopic and non-wicking dielectric material or be rendered such by the filling compound.

Filling Compound
A filling compound must be applied into the interior of the loose tube fiber tubes and into the interstices of the core.

The material must be homogenous, non-hydroscopic and uniformly mixed; free from dirt, metallic particles and other foreign matter; easily removed; non-toxic and present no dermal hazards.

Instead of a non-hydroscopic compound, a water- phixotropic gel containing super-absorbent polymer material may be used.

The filling compound shall be compatible with the cable components.

Inner Jacket
For armored cable, an inner jacket is required. The inner jacket may be applied directly over the core or strength members.

The inner jacket can be either black or natural polyethylene. If natural polyethylene is used, the requirement for absorption coefficient and the inclusion of furnace black are waived.

Armor
The armor shall be corrugated steel with a plastic coating. The plastic coated steel armor shall be applied longitudinally directly over the inner jacket.
The armor for each length of cable shall be electrically continuous.

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Flooding Compound
A flooding compound must be applied between the inner jacket and armor and between the armor and outer jacket. The use of a flooding compound between the armor and outer jacket will not be required if the armor is bonded to the outer cable jacket.

In lieu of a flooding compound, water-blocking tapes may be used to prevent water migration.

The flooding compound must be compatible with the cable jackets.

Outer Jacket
The outer jacket must be tough, flexible, protective covering which can withstand exposure to sunlight, to atmosphere temperature and to stresses reasonably expected in normal installation and service.

The outer jacket shall be free of holes, splits, blisters, or other imperfections and shall be smooth and concentric.

The outer jacket shall be a high or medium density polyethylene and in accordance with ASTM D 1248, Type II or III, Category 4 or 5. The material used must contain an antioxidant and 2.60 ± 0.25 % of furnace black. The light absorption coefficient of the jacket must be a minimum of 400 at a wavelength of 375 nm in accordance with ASTM D 3349.

Mechanical Requirements

Maximum Tensile Loading:

Installation -	2700N
Long term installation -	600N

The fiber optic cable to be supplied shall be tested in accordance with the specifications in REA PE-90, Section 17 for "Mechanical Requirements" and
meet or exceed the test for cable bend, cable impact, cable compression, cable twist, cable flex, water penetration and compound flow.

FIBER OPTIC CABLE PRE-ASSEMBLED IN INNERDUCT
Outside (single mode, armored) fiber optic cable shall be factory installed into direct burial innerduct.

Outside Cable
The outside fiber optic cable shall be armored, of the size, and type as specified in these Contract Documents.

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Innerduct
The innerduct shall be extruded from high-density polyethlene (HDPE) resin and conforming to the minimum standards for polyethylene PE345430B as defined in ASTM D3350 and having the minimum properties.

Tested Properties	ASTM Test Method	Minimum Performance
Tensile Yield	D-638	22 MPa
Flexural Modulus	D-790	758 MPa

The innerduct shall be free from holes, splits, blisters, inclusions and other performance affecting imperfections.

The innerduct shall conform to the nominal dimensions as defined in ASTM D-3035, for SDR 11.0, controlled outside diameter.

NPS Norm. ID	Min. ID, mm	Max. ID, mm	Nom. OD, MM	Min. Wall, mm
1 ¼	34.5	34.7	42.15±0.3	3.8+0.66

The innerduct to be provided shall be a solid color. The color shall be stable to fading and resistant to discoloration. The color of the innerduct shall be black.
Operating temperature range -20°C to +60°C.

Underground Warning Tape
Underground Warning Tape shall be a heavy-duty polyethylene material that is compounded for direct burial service and which will resist acids, alkalis and other soil substances. The tape shall be orange with a continuous legend " CAUTION BURIED FIBER OPTIC CABLE" print in black. The underground warning tape shall be 152 mm (6") wide and have a minimum thickness of 4 mils.

Terminating Plug
Terminating plug shall be corrosion proof, chemical resistant, removable, reusable and provide a light, air and gas tight seal around the installed wire or cable. The terminating plug shall have an individual entry port for each installed wires or cables.

The single mode optical fibers to be contained in the manufactured cables must have characteristics that will allow signals, having a range of wavelengths, to be carried simultaneously.

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Operating Temperature

Storage: -40°C to +70°C
Long Term: 0°C to +70°C

Fiber size

Core diameter - 8.3 μm
Cladding diameter - 125 μm
Buffer diameter - 900 μm

The optical fiber characteristics shall meet the standards as specified above.

Transmission Performance

Maximum Attenuation - 1.0 dB/km @ 1310 nm
0.75 dB/km @ 1550 nm

Mechanical Requirements

Maximum Tensile Loading:
Installation - 10500 N
Long term installed - 5250 N

The fiber optic cable shall be of all dielectric construction, single jacket and of a tight buffered design.

The color-coding shall be in accordance with EIA/TIA - 598. The Engineer and/or an IFOS Communication representative must approve any other color-coding scheme.

Cable Identification and Length Marker

The fiber optic cable must be permanently labeled identifying the cable as fiber optic cable, year of manufacture and manufacturer on the outer jacket. These markings shall be printed on the jacket at regular intervals not exceeding 2 meters.

The fiber optic cable shall have continuous sequentially numbered length markers in "Meters" at regular intervals not exceeding two (2) meters along the outside of the jacket for given length of cable. The agreement between the actual length of cable and the length marking on the cable jacket must be within the limits of +1 % to –0%.

All markings shall be a clear, distinguishable, contrasting, dimensioned and spaced to produce a good legibility. The height of the markings shall be approximately 3 mm.

Fiber Optic Cable Certification

The Contractor as part of the "System Documentation" submittal shall submit the cable

manufacturer's test results and certification that the fiber optic cables to be supplied meet the material requirements of these Contract documents.

Cable Support System

Cable support system can be either a cable tray or a cable hanging system.

Splice Cases:

The Contractor shall furnish and install fiber optic splice cases in locations where splices require protection. The typical location where they will be required is in pullboxes /manhole vaults where the fiber optic trunk cable will be spliced to fiber optic drop cables. The splice cases shall meet the following minimum requirements:

- The case shall be constructed of a rigid, high strength plastic material. The case shall be waterproof with the appropriate gaskets and protection to provide moisture integrity. When installed, the case shall be capable of withstanding severe conditions of moisture, vibration, impact, cable stress and temperature extremes.
- The case shall be capable of holding the type of splice trays specified herein, for fusion splices. The case shall have the capability of holding trays from various manufacturers. The basic case shall have the capacity to hold three (3) splice trays with 4 splices per tray.
- The basic case shall have the input/output capacity for 6 cables.
- The case shall be re-enterable without disturbing the fibers or the fiber splices. No special tools shall be required for installation of maintenance of the case. All hardware and miscellaneous parts shall be standard industry equipment.
- The splice case shall be mountable to standard U-shaped sign channels using stainless steel hardware, or manufacturer approved hardware. Mounting shall be as shown on the details.
- Nominal dimensions of the basic case shall be 560 mm (22") long by 230 mm (9") wide by 230 mm (9") high. The basic case shall weigh 9 kg (20 lb) maximum.
- The splice case shall have a termination block to terminate the central strength members of the fiber optic cables.

Splice Trays:

The Contractor shall furnish and install fiber optic splice trays to organize and store splices within splice cases. The trays shall be compatible with the fiber optic splices and splice cases specified herein and shall meet the following minimum requirements:

- The tray shall have the capacity for 4 splices. It shall be compatible with the fusion splices specified herein.
- The tray shall accommodate up to 8 loose tube buffers. No cable ties are to be used. The loose tube buffers shall be secured with a tube guide or channel snap.

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- The tray shall accommodate both 250 micron and 900 micron fiber.
- Slack fiber within the tray shall be placed in an oval shape along an inside wall of the tray.
- The fiber optic splice trays shall be stackable within the splice case. Any tray within a stack shall be accessible without disassembly of any of the other trays.
- The nominal dimensions of the splice tray shall be 406 mm (16") long by 114 mm (4.5") wide by 13 mm (0.5") high.

CONSTRUCTION DETAILS

The fiber optic cables, associated equipment and devices shall be installed in accordance with industry standards and manufacturer's written instructions. Cables shall be installed as shown on the Plans and as ordered by the Engineer and/or an IFOS Communication representative.

The fiber optic cable shall be installed without damage to fibers, cladding, or jacket. Wheels, pulling sheaves and cable guides shall be used to maintain the fiber optic cable bending radius as specified by the manufacturer. No bends smaller than those recommenced by the manufacturer shall be permitted.

All fiber optic cable placements shall be accomplished using pull, push or push/pull method. Fiber optic cable tension shall be monitored at all times with the use of an approved tension gauge and a recorder. All records of the fiber optic cable installation shall be submitted to the Engineer and/or an IFOS Communication representative for approval. Fiber optic cable subjected to tensions and/or stresses greater than those allowed by the manufacturer shall be removed and replaced at no cost.

The use of pulling lubricants shall be in accordance with the cable manufacturer's recommendation.

At each manhole/vault used as splicing locations, a minimum 6.1 meters (20 ft) of slack shall be neatly coiled and racked in the vault, or as directed by the Engineer and/or an IFOS Communication representative.

Fiber optic cable end caps shall be kept sealed at all times during installation, using approved end caps. Tape shall not be permitted to seal the cable end. The cable shall remain sealed until the fiber optic cable is terminated.

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Fiber optic cables which must be installed through floors or fire rated walls shall be installed in a 76 mm (3 inch) galvanized sleeve and sealed with a fire stop material meeting ASTM E-814 standards.

Fiber optic cable pre-assembled in innerduct shall be installed in continuous lengths between pullboxes and/or splice/vaults. Splicing of fiber optic cable pre-assembled in innerduct shall not be permitted.

All bends of the fiber optic cable pre-assembled in innerduct shall be made without kinking, flattening or appreciably reducing the internal diameter of the innerduct and as recommended by the manufacturer. The minimum bend radius shall be 1220 mm (4 ft).

Fiber optic cable pre-assembled in innerduct that terminate in a pullbox or splice/pullbox shall be sealed in accordance with the pullbox or splice/pullbox manufacturer's instruction as shown on the Plans or as directed by the Engineer and/or an IFOS Communication representative.

All fiber optic cable pre-assembled in innerduct shall be sealed during installation and when being stored. The proposed sealing method shall be approved by the Engineer or an IFOS Communication representative.

All fiber optic cable pre-assembled in innerduct terminating in pullboxes or splice/pullboxes shall have a terminating plug installed in accordance with the manufacturer's instructions.

Pre-assembled innerduct shall be installed in continuous lengths between pullboxes and/or splice/pullboxes. Splicing of innerduct will not be permitted or approved by the Engineer or an IFOS Communication representative.

Pre-assembled innerduct shall be installed by direct burial method or in conduit systems or methods as approved by the Engineer and/or an IFOS Communication representative.

The underground warning tape will be installed during trench backfilling for the pre-assembled innerduct. The underground warning tape shall be located directly above the pre-assembled innerduct 300 mm (12 inches) below finished grade.

Fiber Optic Cable Testing

All testing is to be performed in the presence of the Engineer and/or an IFOS Communication representative. Testing shall follow the criteria established by the Air Force Research Laboratory, attached to this specification (titled Section 9, Test and Acceptance Procedures).

1. Test plan shall include, but not limited to, test for continuity, length, anomalies and attenuation.
2. Documentation

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The Contractor shall submit sample forms for documenting cable, splice and connector losses; OTDR traces and anomalies. The form shall include manufacturer, model number, serial number and date of calibration test equipment. The sample forms shall be submitted for approval 60 working days after the Contract award date.

OTDR traces shall be submitted on paper media and as data to be displayed on a personal computer as part of a furnished software package for analysis of trace waveforms as specified in these Contract Documents.

Interim documentation - After the successful completion of each required test the Contractor shall submit, within three (3) working days, two (2) paper media copies of the tests results to the Engineer and/or an IFOS Communication representative.

Final documentation – The Contractor shall provide two (2) copies for all testing results, which shall be in a book form. Paper media shall be sealed in a clear media to prevent yellowing and to preserve the documents. All test results which are on a removable media for displaying on a personal computer shall be placed in holders designed for that media. Final documentation shall be submitted to the Engineer and/or an IFOS Communication representative 30 working days after completion of the System Acceptance Test.

Minimum required test:

Cable on reel test-single direction OTDR test, at 1310 nm, test all fiber in the cables. This test shall be performed when the cable is delivered to the job location and prior to installation.

b. Segment testing – after installation of a segment of cable a single direction OTDR test, at 1310 nm, test of two fibers in each buffer tube of the installed cables.
c. Splice testing – after any splice has been installed a single direction OTDR test of all fibers, at 1310 nm and 1550 nm. For splices contained in splice/pull boxes, this test shall be performed after the splice/pull box has been closed.
d. System Acceptance Test - end to end testing of the completed system shall consist of a bi-directional test of all fiber in all cables; using an OTDR, at 1310 nm and 1550 nm; using a laser source and power meter measure loss and power level at 1310 nm and 1550 nm.

Minimum acceptance criteria:

a. Attenuation (maximum):
   - Outside fiber optic cable: 1310 nm - 0.35 dB/km; 1550 nm - 0.25 dB/km.
   - Plenum fiber optic cable: 1310 nm – 1.0 dB/km; 1550 nm – 0.75 dB/km
b. Anomalies: No event shall exceed 0.3dB.
c. Splices: Loss shall be 0.10dB or less. Return loss shall be at least 40dB.

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Test documentation

Each test performed shall be documented and submitted to the Engineer and/or an IFOS Communication representative for approval.

METHOD OF MEASUREMENT

Single Mode Fiber Optic Cable (72 Fibers) – Armored; shall be measured for payment as the number of meters of each type of fiber optic cable furnished, installed, tested and documented.

BASIS OF PAYMENT

The unit price bid per linear meter for Single Mode Fiber Optic Cable (72 Fibers) – Armored; shall include the cost of furnishing all labor, materials, tools, equipment, testing, test equipment, safety requirements, documentation and incidentals as necessary to complete the work.

Payment for splicing, and connections to the existing fiber optic line will be include in the bid price for this item.

Progress payments will be made as follows:

Twenty percent (20%) of the bid price will be paid when the cable is installed and having passed the Segment Test. Thirty percent (30%) of the bid price will be paid when the cable has passed the Splice Test. Forty percent (40%) of the bid price for will be paid when the cable has passed the System Acceptance Test. Ten (10%) percent of the bid price for the cable will be paid at Final System Acceptance.

ITEM C680.5170 M - FURNISH AND INSTALL POLYMER/CONCRETE MANHOLE/VAULT

DESCRIPTION:

This work shall consist of furnishing and installing polymer concrete vault/manholes in accordance with the plans and specifications, or as directed by the Engineer.

MATERIALS:

This specification covers the material requirements for polymer concrete manhole/vault used for splicing and pulling of fiber optic cables, communication cables and cables of electrical systems.

In addition to the requirements shown on the plans, the manhole/vault shall be constructed of polymer concrete consisting of sand and aggregate bound together with a polymer resin. Internal reinforcement may be provided by steel, fiberglass, fiber reinforced polymer, or any combination thereof.

The boxes shall be grey or green and shall be of the approximate size shown on the plans. The boxes shall have open bottoms for natural drainage. The boxes shall be placed on a No. 2 crushed stone or gravel drainage bed in accordance with Subsection 703-02. A polymer concrete cover with the same specifications as the box shall be included with each installation.

Covers shall have a minimum coefficient of friction of 0.50 without using a coating. The manhole/vault cover shall have sufficient strength to withstand an impact of an HS-20 vehicle live load without damage. A minimum of at least four (4) bolts shall be used to lock the cover in place.

The manhole/vault shall also include a cable rack for the support of cable splices.

The manhole/vault shall be tested as minimum to the following ASTM standards:

Tested Properties	ASTM Test Method
Tensile Strength	D-2343
Compression Strength	D-3410
Flexural Strength	D-790
Accelerated Service	D-756, Procedure E
Water Absorption	D-570-63, Section 5, 6.1, 6.5
Simulated Sunlight Exposure	D-1501-71, Procedure B
Flammability	D-635

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Chemical Resistance	D-543-47, Section 7, Procedure 1
Chemical Concentration	
Sodium Chloride	5%
Sulfuric Acid	0.1N
Sodium Sulfate	0.1N
Hydrochloric Acid	0.2N
Sodium Hydroxide	0.1N
Kerosene	per ASTM D-543

Cable retainers, splice trays and attachment hardware shall be manufactured from corrosive resistant materials.

CONSTRUCTION DETAILS:

The manhole/vault shall be installed in accordance with the details shown on the plans.

Sections 680-3.01, .04, .06, .09, .12, .13 and .14 of the Standard Specifications shall apply.

The manhole/vault shall be installed in conformance with this specification and as shown in the plans. Any holes for conduit and cable entry shall be carefully drilled or punched into the side of the splice/pull box. After insertion of conduits or cables, holes shall be tightly and thoroughly sealed to the satisfaction of the Engineer.

Backfill material and compaction shall meet the requirements of Section 203-3.15 of the Standard Specifications. The manhole/vault ring and cover shall be set to final grade as shown on the plans.

METHOD OF MEASUREMENT:

The item will be measured for payment as the number of each unit furnished and installed in accordance with the contract documents or as directed by the Engineer.

BASIS OF PAYMENT:

The unit price bid for the polymer concrete manhole/vault box shall include the cost of furnishing all equipment, materials, incidentals, labor, tools and documentation required to complete the work. All covers, crushed stone or gravel, extensions, saw cutting, excavation, backfill and restoration of

adjacent surfaces shall be included in the cost of this item.

ITEM 08520.5014 M - SAW CUTTING ASPHALT PAVEMENT, CONCRETE PAVEMENT AND ASPHALT OVERLAY ON CONCRETE PAVEMENT

DESCRIPTION:

Under this item, the contractor shall saw cut existing asphalt pavement, concrete pavement, asphalt surface course, or asphalt concrete overlay on concrete pavement at the locations indicated on the plans or where directed by the Engineer.

MATERIALS:

None specified.

CONSTRUCTION DETAILS:

Existing pavement and overlay shall be saw cut perpendicular to the roadway surface along neat lines, and to the depth indicated on the plans and typical sections. A power saw approved by the Engineer shall be used for cutting asphalt surface course and asphalt overlay. A power saw shall be used for cutting concrete pavement. After the existing asphalt pavement, concrete pavement, asphalt surface course or overlay has been saw cut through, the contractor may use pry bars, pneumatic tools or other methods approved by the Engineer, to pry loose the existing pavement from that pavement which is to remain. A pavement breaker, under the supervision of the Engineer, may be used to break up the pavement to be removed after the pavement has been completely saw cut through and completely free from the pavement to remain.

Any existing pavements and curbs not indicated to be removed that are damaged by the contractor's operations, shall be repaired by him to the satisfaction of the Engineer at no additional cost to the State.

METHOD OF MEASUREMENT:

The quantity to be measured will be the number of meters of saw cutting done in accordance with the plans, typical sections and the directions of the Engineer.

No saw cutting will be measured for payment under this item which the contractor may choose to do for his own convenience.

BASIS OF PAYMENT:

The unit price bid per meter of saw cutting shall include the cost of all labor, materials, and equipment necessary to complete the work.

Payment for removal and disposal of cut pavement shall be paid for under the appropriate excavation item.

Section 9
Test and Acceptance Procedures

9.0 Test and Acceptance Procedures

Test and acceptance of the fiber optic cable will be performed throughout the installation of the fiber optic system. Initial testing of the cables (singlemode and multimode) will be performed while the cables are still on the reels. Final testing will be performed using "End to End" techniques with the system fully installed. Detailed procedures for testing and acceptance are described below.

An Optical Power Meter and an Optical Time Domain Reflector (OTDR) is required to adequately perform the job.

9.1 Singlemode Cable

9.1.1 Pre-Installation

With the cable still on the reel, an OTDR will be used to verify actual cable length and characteristics. The data obtained will be used as a reference for that particular cable. Once the cable is installed and buried, another OTDR reading will be taken to ensure that no cable damage occurred during the installation procedure.

Step 1. Turn on the OTDR and set it up according the manufacturers procedures. The OTDR should be set up in the following mode:

Wavelength:	1300nm
Cable type:	Singlemode
Intensity:	Medium to High
Pulse Width:	Short
Display Mode:	Distance
Marker 1:	0.0 km
Distance/div:	500 meters
Vertical Scale:	2 db/div

A piece of fiber must be placed before the test cable so that the test cable is not within the Null Zone of the OTDR.

Step 2. Adjust any controls as needed so that the entire trace fits properly on the OTDR screen. Typically these will be the Distance/div and the Vertical Scale controls.

3. Position Marker 1 at the start of the test cable and Marker 2 at the end of the test cable. Record the cable length and save the trace to disk if the capability to do so exists.

Step 4. Set the Display Mode on the OTDR to Loss (in dB). Set the reference marker (0 dB) to the beginning portion of the trace where linearity begins. If an automated feature is available on the OTDR this feature should be utilized to provide consistency across several readings.

Step 5. Position Marker 2 at the end of the cable trace and measure the cable loss. Check the OTDR manual to determine whether the displayed loss is the one-way loss or the return loss (two-way). If this is a selectable option on the OTDR, select the one-way loss mode. If only a two-way return loss reading is

available, divide the loss by two to get the effective one way cable loss.

Step 6. Examine the trace for any discontinuities or reflections. If they exists, they are indications of breaks and fractures. They will need to be more closely examined by using the zoom feature on the OTDR. The location and characteristics of the reflections need to be recorded and saved.

Step 7. Record the reading for the fiber and save the trace to disk if the capability to do so exists.

Step 8. Repeat Steps 2 through 7 for each fiber in the cable and record the measured values. Ensure that the measured values are consistent with the manufacturers cable specifications.

9.1.2 Post-Installation

An OTDR will be used to verify the actual cable length, characteristics and the quality of the splices. The data obtained for the cable will be used as a final reference for the installed system. Subsequent OTDR readings taken at later dates will be used to ensure that the cable has not been damaged or tampered with.

End to end transmission losses will be taken using a laser light source and an optical power meter. These readings will be used as the actual end to end losses for the fiber. The readings will be taken in both directions since readings taken in only one direction may not accurately represent the loss in the other direction due to cable mis-alignment and discontinuities at the splices.

9.1.3 OTDR Verification

Step 1. Turn on the OTDR and set it up according to the manufacturers procedures. The OTDR should be set up in the following mode:

Wavelength:	1300nm
Cable type:	Singlemode
Intensity:	Medium to High
Pulse Width:	Medium/Short
Display Mode:	Distance
Marker 1:	0.0 km
Distance/div:	1000 meters
Vertical Scale:	5 db/div

A piece of fiber must be placed before the test cable so that the test cable is not within the Null Zone of the OTDR.

Step 2. Adjust any controls so that the entire trace fits properly on the OTDR screen. Typically these will be the Distance/div and the Vertical Scale controls.

Step 3. Position Marker 1 at the start of the test cable and Marker 2 at the end of the test cable. Record the cable length and save the trace to disk if the capability to do so exists.

Step 4. Set the Display Mode on the OTDR to Loss (in dB). Set the reference marker (0 dB) to the beginning portion of the trace where linearity begins. If an automated feature is available on the OTDR this feature

should be utilized to provide consistency across several readings.

Step 5. Position Marker 2 at the end of the cable trace and measure the cable loss. Check the OTDR manual to determine whether the displayed loss is the one-way loss or the return loss (two-way). If this is a selectable option on the OTDR, select the one-way loss mode. If only a two-way return loss reading is available, divide the loss by two to get the effective one-way cable loss.

Step 6. Examine the trace for any discontinuities or reflections. If they exist, compare them with the data from the individual traces. A determination must be made if the irregularities were caused by the installation process or if they existed before the cable was installed. They will need to be more closely examined using the zoom feature on the OTDR. The location and characteristics of the reflections need to be recorded and saved.

Step 7. Record the reading for the fiber and save the trace to disk if the capability to do so exists.

Step 8. Repeat Steps 2 through 7 for each fiber in the cable and record the measured values. Ensure that the measured values are consistent with the manufacturers cable specification.

9.1.4 Optical Power Meter Verification

Step 1. Turn on the optical power meter and set it up according the manufacturers procedures. The power meter should be set up in the following mode:

Transmitter -

Wavelength:	1300 nm
Cable type:	Singlemode
Intensity:	Medium to High

Receiver -

Wavelength:	1300 nm
Cable type:	Singlemode
Resolution:	Maximum available
Readout Mode:	Relative Power

Step 2. Connect the transmitter to the receiver using the actual cables used to connect to the patch panels. Set the attenuation on the receiver as appropriate and zero the power meter.

Step 3. Using either telephone or radio communication, establish communications with an individual at the other end of the cable be measured. Measure and record the optical loss in all of the fibers within the cable assembly. Verify the readings are comparable to those obtained using the OTDR.

Step 4. Once the optical loss in a cable has been established, reverse the transmitter and receiver and re-measure the optical loss in the cable. The light path should be opposite that of the previous test. Ensure that the readings are consistent with the first set of readings. Inconsistencies indicate faulty splices or differences in cable diameters at the splices.

Step 5. Repeat Steps 1 through 4 for all other fibers and cables. All measurements will be kept for future reference.

9.2 Multimode Cable

9.2.1 Pre-Installation

With the cable still on the reel, an OTDR will be used to verify actual cable length and characteristics. The data obtained for the cable will be used as a reference for the particular cable. Once the cable is installed and buried, another OTDR reading will be taken to ensure that no cable damage occurred during the installation procedure.

Step 1. Turn on the OTDR and set it up according the manufacturers procedures. The OTDR should be set up in the following mode:

Wavelength:	1300nm
Cable type:	Multimode
Intensity:	Medium
Pulse Width:	Short
Display Mode:	Distance
Marker 1:	0.0 km
Distance/div:	200 meters
Vertical Scale:	2 db/div

A piece of fiber must be placed before the test cable so that the test cable is not within the Null Zone of the OTDR.

Step 2. Adjust any controls as needed so that the entire trace fits properly on the OTDR screen. Typically these will be the Distance/div and Vertical Scale controls.

Step 3. Position Marker 1 at the start of the test cable and Marker 2 at the end of the test cable. Record the cable length and save the trace to disk if the capability to do so exists.

Step 4. Set the display mode on the OTDR to loss (in dB). Set the reference marker (0 dB) to the beginning protion of the trace where linearity begins. If an automated feature is available on the OTDR this feature should be utilized to provide consistency across several readings.

Step 5. Position Marker 2 at the end of the cable trace and measure the cable loss. Check the OTDR manual to determine whether the displayed loss is the one-way loss or the return loss (two-way). If this is a selectable option on the OTDR, select the one-way loss mode. If only a two-way return loss reading is available, divide the loss by two to get the effective one-way cable loss.

Step 6. Examine the trace for any discontinuities or reflections. If they exist, they are indications of breaks and fractures. They will need to be more closely examined using the zoom feature on the OTDR. The location and characteristics of the reflections need to be recorded and saved.

Step 7. Record the reading for the fiber and save the trace to disk if the capability to do so exists.

Step 8. Repeat Steps 2 through 7 for each fiber in the cable and record the measured values. Ensure that the measured val-

ues are consistent with the manufacturers cable specifications.

9.2.2 Post-Installation

An OTDR will be used to verify the actual cable length, characteristics and the quality of the splices. The data obtained for the cable will be used as a final reference for the installed system. Subsequent OTDR readings taken at later dates will be used to ensure that the cable has not been damaged or tampered with.

End to end transmission losses will be taken using a laser light source and an optical power meter. These readings will be used as the actual end to end losses for the fiber. The readings will be taken in both directions since readings taken in only one direction may not accurately represent the loss in other direction due to cables misalignment and discontinuities at the splices.

9.2.3 OTDR Verification

Step 1. Turn on the OTDR and set it up according to the manufacturers procedures. The OTDR should be set up in the following mode:

Wavelength:	1300nm
Cable type:	Multimode
Intensity:	Medium
Pulse Width:	Medium/Short
Display Mode:	Distance
Marker 1:	0.0 km
Distance/div:	500 meters
Vertical Scale:	5 db/div

A piece of fiber must be placed before the test cable so that the test cable is not within the Null Zone of the OTDR.

Step 2. Adjust any controls so that the entire trace fits properly on the OTDR screen. Typically these will be the Distance/div and the Vertical Scale controls.

Step 3. Position Marker 1 at the start of the test cable and Marker 2 at the end of the test cable. Record the cable length and save the trace to disk if the capability to do so exists.

Step 4. Set the Display Mode on the OTDR to Loss (in dB). Set the reference trace where linearity begins. If an automated feature is available on the OTDR this feature should be utilized to provide consistency across several readings.

Step 5. Position Marker 2 at the end of the cable trace and measure the cable loss. Check the OTDR manual to determine whether the displayed loss is the one-way loss or the return loss (two-way). If this is a selectable option on the OTDR, select the one-way loss mode. If only a two-way return loss reading is available,divide the loss by two to get the effective one-way cable loss.

Step 6. Examine the trace for any discontinuities or reflections. If they exists, compare them with the data from the individual traces. A determination must be made if the irregularities were caused by the installation process or if they existed before the cable was installed. They will need to be examined

oser by using the zoom feature on the OTDR. he location and characteristics of the reflec- ons need to be recorded and saved.

tep 7. Record the reading for the fiber nd save the trace to disk if the capability to do o exists.

Step 8. Repeat Steps 2 through 7 for each fiber in the cable and record the measured values. Ensure that the measured values are consistent with the manufacturers cable specification.

9.1.4 Optical Power Meter Verification

Step 1. Turn on the optical power meter and set it up according the manufacturers procedures. The power meter should be set up in the following mode:

Transmitter -

Wavelength:	1300 nm
Cable type:	Multimode
Intensity:	Medium to low

Receiver -

Wavelength:	1300 nm
Cable type:	Multimode
Resolution:	Maximum available
Readout Mode:	Relative Power

Step 2. Connect the transmitter to the receiver using the actual cables used to connect to the patch panels. Set the attenuation on the receiver as appropriate and zero the power meter.

Step 3. Using either telephone or radio communication, establish communications with an individual at the other end of the cable be measured. Measure and record the optical loss in all of the fibers within the cable assembly. Verify the readings are comparable to those obtained using the OTDR.

Step 4. Once the optical loss in a cable has been established, reverse the transmitter and receiver and re-measure the optical loss in the cable. The light path should be opposite that of the previous test. Ensure that the readings are consistent with the first set of readings. Inconsistencies indicate faulty splices or differences in cable diameters at the splices.

Step 5. Repeat Steps 1 through 4 for all other fibers and cables. All measurements will be kept for future reference.

ITEM C680.935348 M - TELEPHONE CABLE, 50 PAIR, NO. 22 AWG

DESCRIPTION:

Under this item, the contractor shall furnish and install twisted-pair telephone cable in accordance with the plans or where directed by the Engineer and/or an IFOS Communication representative. This item shall also include the required cable splices inside the manhole/vault structures.

MATERIALS:

The telephone cable shall comply to the requirements of REA Specification PE-39 (REA type BFCC) table for direct burial, aerial and duct applications. Cable shall be 50-pair, 22 AWG.

The Contractor shall provide all necessary connecters, terminators, splice hardware and mounting hardware to install a completely operational system.

Physical Characteristics

Conductors:	Solid, soft drawn, annealed bare copper, 22 AWG. The number of pairs shall as specified in the plans.
Insulation:	Solid, virgin, high-density polyolefin, with telephone industry color coding.
Cable Core Assembly:	Insulated conductors are twisted into pairs with varying lays (twist lengths) to minimize crosstalk and meet strict capacitance unbalance limits.
Shielding:	127 mm thick corrugated solid copper tape applied longitudinally with overlap to provide 100% electrical shielding coverage.
Outer Jacket:	A black, low density, high molecular weight, virgin polyethylene, compounded to withstand direct exposure to sunlight , temperature variations, and other environmental conditions, including abuse during installation.
Distance Marking:	Incremental distances shall be printed sequentially along the outer jacket at increments to excess 615 mm (24").

Electrical Characteristics

Conductor Resistance:	Ohms/km at 20°C	56.6	(mean)
Insulation resistance:	Megohm/km	1600	(min)
Dielectric Strength:	Insulation capable of withstanding 3 seconds dc voltage		
	Between conductors-volts	5000	(min)
	Between conductors and shield-volts	15,000	(min)

ITEM C680.935348 M - TELEPHONE CABLE, 50 PAIR, NO. 22 AWG

Attenuation:	At 772kHz, dB/km	13.1 (mean)
Average Mutual Capacitance:	nF/km at kHz	52 ± 4
Capacitance Unbalance:	picofarad/km (Pair to Shield):	1.45 (max)
	picofarad/km (Pair to Shield):	2625 (max)
Crosstalk Loss:	NEXT at 772 kHz	42 dB (min)
	FEXT at 772 kHz	43 dB (min)

CONSTRUCTION DETAILS:

Sub sections 680-3.15, 680-3.16, 680-3.18 and 680-3.19 of the Standard Specifications shall apply.

The telephone cable shall only be installed in accordance with REA, GTE or the manufacturer's recommended procedures. The cable shall be installed without splices for standard reel length of 1525 meters (5000 ft).

At pull box locations, the contractor shall provide an additional 2.5 meters (8 ft) of slack cable. At the location of connection to the telephone utility service, the Contractor shall provide an additional 4.5 meters (15 ft) of slack cable.

The Contractor is responsible to coordinate the entire installation with the Engineer and/or an IFOS Communication representative, inclusive of final terminations.

The Contractor shall submit cut sheets and proposed installation procedures and plans to the Engineer and/or an IFOS Communication representative for approval prior to installation. At a minimum, the installation plan shall include a detailed outline of the proposed telephone utility cable at all pull boxes and utility poles.

Copper Cable Testing

Testing will be accomplished IAW AFI31W3-10-15.
The Contractor shall submit a Test Plan to the Engineer and/or an IFOS Communication representative for approval. All testing is to be performed in the presence of the Engineer and/or an IFOS Communication representative.
Test will be conducted with Test Equipment (such as Fluke CopperPro 990) that records test results that can be printed out.
Test plan shall include, but not limited to, test continuity, length, loop resistance, split pairs, shorts, grounds, and voltage.

ITEM C680.935348 M - TELEPHONE CABLE, 50 PAIR, NO. 22 AWG

Minimum Required Test:

a. Segment Testing – after a segment of cable has been spliced. Perform tests as outlined in test plan.
b. System Acceptance Plan – end to end testing after splices have been sealed. Perform tests as outlined in the test plan.

Minimum Acceptance Criteria:

Split Pairs:	None
Shorts:	None
Grounds:	Infinity
Voltage:	0 Volts
Loop Resistance:	37 ohms per kft

Test Documentation: Each test performed shall be documented and submitted to RRS/IFOS Communication Representative for approval.

METHOD OF MEASUREMENT:

The "TELEPHONE CABLE" item will be paid as the actual number of feet furnished and installed.

BASIS OF PAYMENT:

The unit price (meter) for the "TELEPHONE CABLE" item shall include the cost of all equipment, materials, and labor necessary to complete work.